# FORUM

## A Need for More and Better Nutrients From Plants

The typical American diet today contains more plant-based foods and less meat and dairy products. But red meat and dairy products are the principal dietary sources of the essential minerals iron, zinc, and calcium.

We must find ways to increase the amount and bioavailability of these mineral nutrients in edible seeds, fruits, and other plant organs and tissues. We must also find ways to exploit the array of organic compounds—often called phytonutrients—that are synthesized by plants. We know too little about them and their potential to promote health.

The Agricultural Research Service is ideally suited to be a world leader in this research that is at the interface of food crops and human nutrition. The ARS mission addresses both areas, and the agency already has a model for interdisciplinary research linking the two.

For 60 years, the U.S. Plant, Soil, and Nutrition Laboratory located at Cornell University in Ithaca, New York, has brought together soil scientists, plant biologists, and human nutritionists to investigate plant and soil factors that affect human nutrition and health.

The case for boosting the nutrient content of plant-based foods is already compelling.

For example, iron, zinc, and calcium are particularly important for certain population groups in the United States. Yet only 21 percent of teenage girls consume a diet that meets the Recommended Dietary Allowance (RDA) for iron, while just 16 percent meet the RDA for calcium. Many do not meet the RDAs for zinc, magnesium, and vitamins A and E.

Furthermore, up to 20 percent of premenopausal women have low hemoglobin levels because they do not get enough iron. The figure is worse—40 percent—for pregnant, low-income African-American women. This could have important long-term implications, because recent research indicates that iron deficiency in pregnancy may retard a young child's cognitive development.

Iron deficiency, the world's most common mineral deficiency, affects 2 billion people and is especially severe in developing countries. Research to enhance the content and bioavailability of iron in food staples such as cereal grains—which typically are low in iron—should have a high priority everywhere.

But plant-based foods are not only important as sources of essential minerals, vitamins, protein, lipids, and carbohydrates. They also synthesize and accumulate an astonishing array of organic secondary compounds. Data increasingly show that several of these compounds have health-promoting properties.

About 100,000 secondary compounds are synthesized by different plant species. While they appear to play no direct role in plant growth and development, many of these compounds are known to act in processes critical to a plant's survival. For example, some help defend against attack by herbivores and disease-causing organisms—or against stresses such as damage by ultraviolet radiation.

These secondary plant compounds include a spectrum of complex organic molecules that include phytoestrogens, isoflavonoids, anthocyanins, polyphenols, and glucosinolates. They have not been shown to be dietarily essential—in contrast to many minerals and vitamins. But they may help improve or maintain human health by reducing the likelihood—or slowing the onset—of chronic diseases, such as heart disease and cancer, as well as the effects of aging.

Our challenge is to find ways to take greater advantage of these phytonutrient compounds through diet.

Thanks to advances in plant genomics and biotechnology, plant scientists have an array of powerful new tools to complement traditional and molecular-assisted methods of plant breeding. These tools better equip us to understand the mechanisms and regulation of plant compounds' complex transport and biosynthetic pathways. With this kind of knowledge, we can speed the design of strategies to alter a plant's amount, distribution, and forms of both essential nutrients and phytonutrients.

But for these efforts to succeed, we need stronger interdisciplinary linkages between plant biologists, human nutritionists, and food scientists.

Plant biologists must continuously seek the newest evidence on biological roles of plant foods in the human body. Nutritionists need to become increasingly well informed about possibilities for the biochemical and molecular manipulation of phytonutrients—as well as possible obstacles to accomplishing this. And food scientists should see new opportunities for products that will capitalize on these functional enhancements of plant-based ingredients.

I foresee a time when human nutritionists will identify specific compounds for plant biologists to target. Plant scientists will then alter the compounds' quantity or form—or both. The modified plant food will be tested with animal or in vitro models or through clinical trials. Findings will feed back to plant biologists, who will make additional modifications to the plants.

Currently, scientists at our laboratory in Ithaca are taking advantage of recent advances in plant molecular biology, functional genomics, and biochemistry to enhance their ability to modify and improve the nutritional quality and health-promoting properties of plant foods.

This new field, named "nutritional genomics," holds considerable promise for providing Americans with a more nutritious and healthier food supply in the near future.

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